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(54) **Modem with digital isolation**

Modem mit digitaler Isolation

Modem avec isolation numérique

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to modems and, more particularly, eliminates the relatively large isolation transformer from the modem while changing isolation from the analog signal region to the digital signal region to avoid analog distortion, and obviate the isolation transformer.

Prior Art

One problem of the prior art is the fact that the Data Access Arrangement (DAA), which interfaces between the telephone lines and the modem, is too large and heavy for the new "credit card" minimal size modem cards.

Just as data speeds are growing, modem size is decreasing. Modems are becoming an integral part of all LapTop/PalmTop computers. Because these computers are small, size and weight are at a premium. With the growing data rates, minimum distortion is a must. Distortion is one of the limiting factor for high speed modems.

Many modems available on the market today utilize an isolation transformer in the DAA section. While the transformer protects the electronic circuits, it also introduces distortion, consumes real estate and is the heaviest part of the modem section. In the case of portable computers, minimum weight is a priority requirement.

By eliminating the transformer and the distortion that comes with it, an increase in the data rate capabilities of the modem is realized. Size, weight and cost are also reduced significantly.

Although significant strides in improving performance and reducing the size of modems has been made, the DAA interface circuitry has remained relatively unchanged. In fact, on some of the lap top designs, the DAA occupies almost as much room as the remainder of the modem circuitry.

So far, designers have been able to stay within the packaging constraints by squeezing the parts closer together. However, designers are quickly reaching limits as they are now experiencing problems in meeting the UL and Part 68 high voltage breakdown test. In addition, the physical size of the DAA components prevents the installation of a modem in the new pocket computers.

One of the largest components in the DAA is the transformer. Functionally the transformer satisfies two design requirements.

First, it provides the necessary high voltage isolation between the telephone network and the user. In the United States, this is specified by FCC part 68 which requires 1500 volts. In other countries this isolation may be up to 3750 volts.

Second, it provides the balance interface circuit necessary to meet Part 68, as well as providing good common mode rejection of the noise signals normally on the telco lines.

To support both of these requirements and still maintain a very low distortion level results in a relatively large transformer. For example, the new high performance modems, like v32, require distortion levels of -70dBm or lower. To achieve these levels require special magnetic material and large physical size.

Based on these problems, it is clear that there needs to be an alternate to the analog isolation transformer.

Experience indicates that when one attempts to add isolation circuitry in the analog circuit path, there will always be the problem of adding distortion.

SUMMARY OF THE INVENTION

The invention eliminates the large isolation transformer and provides isolation at the digital interface after conversion from an analog incoming signal and before the conversion to an outgoing analog signal. At this point it is possible to provide the isolation with much less concern with analog distortion. The novel isolation is preferably magnetic, in the form of two tiny pulse transformers. Other digital isolation methods, such as optical are also novel and applicable.

Attention is drawn to US-A-4647721 which relates to a telephone activated power controller. The telephone activated power controller comprises an electrical power inlet and a number of power outlets for supplying power to the devices of a computer or other system. A detection circuit detects telephone rings and OFF-HOOK conditions and powers up the system. The controller also has a surge protection circuit to prevent large voltages or current from reaching the power oulet.

In accordance with the present invention a modem without a conventional isolation transformer as set forth in independent claim 1 and a method of surge protecting and minimizing analog distortion in a modem as set forth in independent claim 11 are provided. Preferred embodiments of the present invention are disclosed in the dependent claims.

The Rockwell modem architecture provides an ideal structure to incorporate the isolation circuitry. This is between the Digital Signal Processor (DSP or CSPX) and the Integrated Analog (IA) device. Functionally, the signals at this interface are digital, and the data rates are moderate. Currently the interface between the CSPX and the IA consists of about 15 discrete lines, which include data, timing and control.

These parallel signals are combined into two serial data streams, one input, and one output. The data is encoded in a time division multiplex, self clocking scheme. All serial encoding and decoding is incorporated within the CSPX and IA devices.

For the above water/ground telephone systems, the modem must pass a metallic voltage surge test which

is a pulse of 800 volts applied between the TIP and RING of the modem. While the modem is at the ON-HOOK state, there is no problem because the seizure relay is off (open), and thus, prevents the surge from getting into the electronic circuits. This 800v surge is also applied while the modem is in the OFF-HOOK state, at which time the line switch is closed and the 800v can cause an irreversible damage to our electronic circuits.

A synergistic result is obtained if the above invention is combined with a detector circuit which senses the appearance of the high level, fast rising surge in the DAA. This circuit disengages the electronics from the line before the surge can reach damaging magnitudes. The active rejection circuit serves as a surge protection unit - replaces the metal oxide varistor (MOV) and the isolation transformer, and provides line seizure switch replacement for the traditional relay. Component count is reduced by removing the transformer, MOV and the relay.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a prior art modem;

FIG. 2 is a block diagram of the present invention;

FIG. 3 shows the surge detector and a line FET;

FIG. 4 shows a typical square wave;

FIG. 4A shows the wave differentiated to save power;

FIG. 5 shows coils for a pulse transformer;

FIG. 5A is a view in cross section of a pulse transformer:

FIG. 6 shows a prior art surge protection circuit when the isolation transformer is present;

FIG. 7 shows the surge protection circuit in the absence of an isolation transformer; and,

FIG. 8 is a circuit diagram of a transformer-less DAA circuit with surge protection.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Currently, the Rockwell modem includes Data Access Arrangement (DAA)9, Integrated Analog (IA) device 11 (FIG. 1) and the Digital Signal Processor 13 (DSP). DAA 9 is connected to IA 11 by wires 10, and IA 11 and DSP 13 are connected by 15 individual wires 15, with the micro processor 14 being connected to DSP 13 by several wires 16. All Data Access Arrangement (DAA) devices 9 and 17 (FIG. 2) require a high voltage isolation between the telephone lines 19,21 and a modem. Usually, transformer 21 (in the DAA section 9) provides this isolation.

FIGs. 3, 7, and 8 detail the cross-referenced invention which uses a FET to open a lead from the telephone line system upon detecting a surge in the DAA section and provides a synergistic combination with the present invention, which is best seen in FIGs. 2, 5 and 5A.

In FIG. 2, the isolation transformer 21 has been eliminated and, instead, tiny pulsed transformers 25,27 are used between the IA device 11' and the DSP 13'. The received integrated analog signal is digitized, and then multiplexed in box 29 and demultiplexed in box 31, whereas the transmitted signal is multiplexed in Box 31A and demultiplexed in box 29A, thus avoiding the 15 wire interconnection and all analog distortion.

Thus, it may be seen that the parallel signals on these leads (15) are combined into two serial data streams, one input and one output. The data is encoded in a time division multiplex, self clocking arrangement. All serial encoding and decoding is incorporated into the Integrated Analog and Digital Signal Processing devices 11' and 13', so that the isolation circuitry may consist only of two pulse transformers 25, 27 or two opto couplers (not shown).

Also, pulsed signals save power. It is only necessary to pass short spikes 35,37 (FIG. 4A), representing up and down transitions of original wave 39, rather than to pass the full wave 39 (FIG. 4). Common mode rejection, as well as, high voltage isolation are attained by the pulse transformers.

FIGs. 5 and 7 show the construction of the pulse transformers 25 and 27 on conventional glass pc board 41 of, e.g. .062" thick. Center holes 36,38 in the board, receive the legs 42,43 and 44,45 of U-bars 40,46 to form the "gaps" where they abut. The coils 37,39 surrounding the respective legs comprise only a few turns of metal, laid down on the board 41, and etched away to leave the coils, which may have diameters of about 1/8 inch. The U-bars are about 1/2 inch in length. The other pulse transformer 27 is spaced away from transformer 25 as far as practical, and the components are the same, bearing the primes of the same numbers. The best magnetic materials are employed for the magnetic path, such as ferrite, and the small dimensions easily fit space minimums.

The frequency of operation is in the megacycle range, and the power losses are extremely low because the pulse technique requires much less power than handling the entire wave. The pulse technique also handles common mode distortion problems.

In lieu of the preferred pulse transformers at the digital interface, other types of isolation may be used. Two opto-couplers are also effective on two serial data streams, i.e. one input and one output, but the pulse transformer isolation uses less power.

For non-common mode, e.g. lightning caused surges, i.e., in above ground telephone systems, the block diagrams of FIGs. 3 and 7 show surge rejection circuits

for use in DAA device 17 of FIG. 2. In FIG. 3, TIP line 51 includes FET 52 (or a fast acting transistor) to open this line. DETECTOR 53 between TIP lead 51 and RING lead 54, senses the surge and very quickly opens FET 52.

FIG. 6 shows PRIOR ART type surge protection for modems, e.g. 57 coupled to telephone lines 58,59. The conventional isolation transformer 60 is shown connected between the telephone lines 58,59 and the modem 57. MOV 61 (metal oxide varistor) is shown connected across the lines to act as a surge absorber. RING DETECTOR 62 is provided to indicate to modem 57 that a ring has appeared and the DSP 13, via IA11, operates LINE SEIZURE RELAY 63.

FIG. 7 shows a preferred surge protection circuit of this invention in the absence of isolation transformer 60. The details of this SURGE REJECTION and LINE SEIZURE SWITCH 65 are set forth In FIG. 8.

In FIG. 8, the ON and OFF Hook lead is shown at 101, supplying +5 volts in OFF HOOK, and the DC. power lead 103 receives +5 volts above ground 105 when the MODEM is on. FET 107 (BUZ 78) serves to open and close TIP lead in the signalling circuit for unexpected surges.

Capacitor 110 in parallel lead 111, including series resistor 112 across TIP lead 109 and RING lead 113, is a .33 μf, 250 volt capacitor and resistor 112 is 10,000 ohms. The pair comprise a dummy load for the RING signal.

Next, a full wave bridge rectifier comprises the four 1N4006 diodes 115, 117, 119 and 121 to insure positive voltage on the drain 123 of FET 107, source 125 being grounded at 105 over lead 127.

The circuit of FIG. 8 must provide protection under a variety of circumstances:

1) The modem's power is OFF at 103.

At this time the FET 107 (Q1) is already in the OFF state. While in the OFF state, the FET will block high voltage from going through. When the fast rising surge arrives, it attempts to charge the FET gate 129 through the internal capacitance of the FET 107. Normally, this will cause the FET to turn ON. However, diode (1N1148) D12 keeps the FET 107 OFF by clamping the gate 129 to ground 105 via the 5v power supply, thus, preventing any charge build-up on the gate 129.

2) The modem's power is ON at 103 and it's ON-Hook at 101.

This case is similar to the previous one in the sense that the FET 107 is still OFF and no DC current is running through it. The FET is OFF because the ON-Hook signal coming through lead 101 keeps the gate 129 at ground level 105. At this time, the JK flip-flop 133 (U2) (74HC112) is powered from lead 103 and can assist in keeping the FET 107 OFF.

When the surge arrives it will pass through C4, shown at 135 (100pf) and becomes a clock to the JK flip-flop 133. Resistor R6, shown at 161, has 47,000 ohms and resistor R4, shown at 162 has 10,000 ohms. This 5:1 ratio determines the extent of the surge voltage necessary to clock JK flip-flop 133 over lead 137, and it can be made adjustable, if desired. As a result the Q output of the JK 133 will go up and turn Q2 140 (2H1222) ON over leads 138 and 127, and 131. Q2 140 will hold the gate 129 of Q1 107 clamped to ground level, which results in keeping the FET 107 at the OFF state.

3) The modem's power is ON at 103 and it's OFF-Hook at 101.

This time around, the FET 107 is conducting line current because its gate receives 5v from the lead 101. The surge will, again, go through C4 135 and clock the JK 133. The Q output of JK will go up and cause Q2 140 to turn ON. Q2 140 will turn the FET 107 OFF as soon as possible before the voltage builds up.

4) The modem's power is ON at 103 and it's OFF-Hook at 101 but no current flows through TIP and RING.

This time the circuit performs the same way as in the last case. This situation is not likely to happen during normal use of the modem, but FCC labs do test the modem powered ON with no TIP and RING current.

In support of the above activities, Q12 142 (2N4403) turns ON any time the JK flip-flop 133 gets clocked and will turn Q14 144 (MJD 47) ON very fast. This action discharges the stray capacitance and the FET's 107 capacitance, preventing a voltage build-up.

R10 145 (47K) and C6 147 (.01μf) hold the Q output of the JK flip-flop 133 at a high level which keeps the FET 107 OFF for about lmSec. This way the FET 107 is turned OFF for a period longer than the expected duration of the surge. In case the surge persists beyond (1MS) the R7 & R5 C5 combination was designed to keep the JK at the clocked state which in turn keeps Q4 107 off.

It should be noted that, for AC purposes, ground 105 is connected to +5 volt lead 103, so a high potential spike or surge across TIP-RING causes the negative side of the pulse to pass via any or several paths in the electronic inductor box 150 up to ground 105 and to lead 103. Thus, the pulse is across the 5:1 voltage divider, R4 162, R6 161.

Also, when FET 107 is going from ON to OFF, there is still some energy passed through it, and voltage builds up across Q14, 144. After the clock, transistor Q12 142 turns on hard by Q bar, Q going up and Q14 144 is then turned on hard, absorbing the energy.

The surge protective circuit can work in any circuit

or modem to protect, e.g., consumer products from non-common mode surges. Thus, the combination of the transformerless DAA with digital pulse transformers and the surge protection circuit precludes both uncommon mode and common mode problems. The digital isolation invention is applicable to most all modems.

The invention may be summarized as providing

a modem without a conventional isolation transformer, wherein
an Integrated Analog device is connected to the Data Access Arrangement and a Microprocessor is connected to a Digital Signal Processor.

The invention is disclosed in the claims and the dependent claims.

Claims

1. A modem without a conventional isolation transformer, comprising in combination:

   a transformerless Data Access Arrangement (9, 17) in communication with a telephone line system (19, 21; 109, 113);
   an Integrated Analog device (11');
   a Digital Signal Processor (13');
   a Microprocessor;
   the Integrated Analog device connected to the Data Access Arrangement and the Microprocessor connected to the Digital Signal Processor;
   pulse transformer means connected between the Integrated Analog device and the Digital Signal Processor;
   TIP and RING leads for communication between the telephone lines and the modem;
   a FET (107) connected to open and close one of said leads;
   an ON/OFF HOOK circuit for supplying operating voltage to said FET when in the OFF HOOK mode; and,
   a first circuit (140) and a second circuit (150);
   a flip-flop circuit for activating said first circuit in one condition and said second circuit in its other condition;
   sensing means (135, 161, 162) connected across said leads for activating said flip-flop circuit to said one condition upon sensing a surge voltage;
   said first circuit (140) preventing said FET from conducting current when said first circuit is activated; and,
   said second circuit resetting the flip-flop circuit after a predetermined time.

2. The modem of claim 1, further comprising: multiplexer means (29) in the integrated analog device for

   a received signal and demultiplexer means (31) in the digital signal processor for the received signal;
   further multiplexer means in the digital signal processor for a transmitted signal and further demultiplexer means in the integrated analog device for the transmitted signal, all of said transmitted signals and received signals passing through said pulse transformer means and being digital whereby analog signal distortion is avoided.

3. The modem of any of the preceding claims, further comprising:

   a first transistor (142) connected to said flip-flop circuit to saturate when the flip-flop circuit is clocked;
   a second transistor (144) connected to the first transistor to turn on rapidly by the second transistor conducting; and,
   a shorting pathway closed by said first and second transistors from the RING lead to ground to discharge stray capacitance including any FET capacitance.

4. The modem of any of the preceding claims, further comprising:
   a rectifier bridge (115, 117, 119, 121) circuit connected between the TIP and RING leads to insure positive voltage to a drain of the FET.

5. The modem of any of the preceding claims, further comprising:
   a resistor-capacitor series circuit (110, 112) connected across the TIP and RING leads to serve as a dummy load for a RING signal.

6. The modem of any of the preceding claims further comprising:
   an electronic inductor (150) for said modem including said first and second transistors and a parallel resistor-capacitor circuit.

7. The modem of any of the preceding claims, wherein:
   said sensing means (135, 161, 162) comprises a series circuit comprising of a capacitor and two resistors with a common point to both resistors being connected to a clock input of said flip-flop circuit, relative values of said resistors determining a point in the surge voltage which activates the flip-flop circuit.

8. The modem of any of the preceding claims, where-

in:

said first circuit comprises a clamping transistor (140) having its base connected to a Q output of the flip-flop circuit and being connected across a source-gate of said FET to ground the gate of the FET when the flip-flop circuit is clocked.

9. The modem of any of the preceding claims, wherein:

said second circuit comprises a resistor-capacitor network (145, 147) connected to a Q bar output of the flip-flop circuit to maintain the Q output of the flip-flop at a high level which keeps the gate of the FET grounded until after the surge voltage has disappeared.

10. A method of surge protecting and minimizing analog distortion in a modem connected to a telephone line system which comprises the steps of:

eliminating the conventional isolation transformer from the DAA section (9, 17), and:
changing the signal isolation from analog signal isolation to digital signal isolation;
disposing a FET (107) in one of the incoming telephone lines for opening and closing said line;
sensing a surge voltage;
preventing said FET from conducting current when said surge voltage is sensed; and,
maintaining the preventing until the surge has passed whereby both common and uncommon problems are eliminated.

11. The method of Claim 10, wherein said digital signal isolation is accomplished by using one of magnetic and optical isolation.

12. The method of Claims 10 or 11, further comprising the step of:

accomplishing said isolation between the Integrated Analog section and the Digital Signal Processor section.

13. The method of any of the preceeding claims, further comprising the step of:

converting the telephone line incoming analog signal to a first serial stream of digital data prior to the digital signal isolation, and converting the outgoing digital signal into a second serial stream of digital data prior to the digital signal isolation.

14. The method of any of the preceeding claims, further comprising the step of:

providing said digital signal isolation by using at least one pulse transformer for each stream of data.

Patentansprüche

1. Modem ohne konventionellen Trenntransformator, wobei in Kombination folgendes vorgesehen ist:

eine transformatorlose Daten-Zugriffsanordnung (Data Access Arrangement) (9, 17) in Verbindung mit dem Telefon-leitungssystem (19, 21; 109, 113)
eine integrierte Analogvorrichtung (11');
ein digitaler Signalprozessor (13');
ein Mikroprozessor;
wobei die integrierte Analogvorrichtung mit der Daten-Zugriffsanordnung verbunden ist und der Mikroprozessor mit dem Digital-Signalprozessor verbunden ist;
Impulstransformatormittel verbunden zwischen der integrierten Analogvorrichtung und dem digitalen Signalprozessor;
Anschluß- und Läuteleiter zur Verbindung zwischen den Telefonleitungen und dem Modem;
ein FET (107) angeschaltet zum Öffnen und Schließen eines der Leiter;
eine Aufgelegt/Abgehoben- (ON/OFF HOOK) Schaltung zur Lieferung einer Betriebsspannung an das FET, wenn die Abgehoben-Betriebsart vorliegt; und
eine erste Schaltung (140) und eine zweite Schaltung (150);
eine Flip-Flop-Schaltung zum Aktivieren der ersten Schaltung in einen Zustand und der zweiten Schaltung in ihren anderen Zustand;
Abfühlmittel (135, 161, 162) verbunden mit den Leitern zur Aktivierung der Flip-Flop-Schaltung in den einen Zustand beim Abfühlen einer Anstiegsspannung;
wobei die erste Schaltung (140) das FET daran hindert, Strom dann zu leiten, wenn die erste Schaltung aktiviert ist; und
wobei die zweite Schaltung die Flip-Flop-Schaltung nach einer vorbestimmten Zeit zurücksetzt.

2. Modem nach Anspruch 1, wobei ferner folgendes vorgesehen ist:

Multiplexermittel (29) in der integrierten Analogvorrichtung für ein Empfangssignal und Demultiplexermittel (31) in dem Digital-Signalprozessor für das Empfangssignal;
ferner Multiplexermittel in dem Digital-Signalprozessor für ein übertragenes Signal und ferner Demultiplexermittel in der integrierten Analogvorrichtung für das Übertragungssignal, wobei sämtliche übertragenen Signale und empfangenen Signale durch die Impulstransformatormittel laufen und digital sind, wodurch Analog-Signalstörungen vermieden wird.

3. Modem nach einem der vorhergehenden Ansprüche, wobei ferner folgendes vorgesehen ist:

ein mit der Flip-Flop-Schaltung verbundener erster Transistor (142), der gesättigt wird, wenn die Flip-Flop-Schaltung getaktet ist;
ein zweiter Transistor (144) verbunden mit dem ersten Transistor, um durch das Leiten des zweiten Transistors schnell eingeschaltet zu werden;
ein Kurzschlußpfad der durch die ersten und zweiten Transistoren von der Läuteleitung oder dem Läuteleiter zur Erde geschlossen wird zur Entladung der Streukapazität einschließlich jedweder FET-Kapazität.

4. Modem nach einem der vorhergehenden Ansprüche, wobei ferner folgendes vorgesehen ist:
eine Gleichrichter-Brückenschaltung (115, 117, 119, 121) geschaltet zwischen die Anschluß- und Läuteleiter zur Sicherstellung einer positiven Spannung an einer Drain des FET.

5. Modem nach einem der vorhergehenden Ansprüche, wobei ferner folgendes vorgesehen ist:
eine Widerstands-Kondensator-Serienschaltung verbunden zwischen den Anschluß- und Läuteleitern, um als eine Ersatzlast für ein Läutesignal zu dienen.

6. Modem nach einem der vorhergehenden Ansprüche, wobei ferner folgendes vorgesehen ist:
eine elektronische Induktivität (150) für das Modem einschließlich der ersten und zweiten Transistoren und einer parallelen Widerstands-Kondensator-Schaltung.

7. Modem nach einem der vorhergehenden Ansprüche, wobei folgendes vorgesehen ist:
die Abfühlmittel (135, 161, 162) weisen eine Serien-Schaltung auf, die einen Kondensator und zwei Widerstände besitzt, und zwar mit einem gemeinsamen Punkt beider Widerstände verbunden mit einem Takteingang der Flip-Flop-Schaltung, wobei Relativwerte der Widerstände einen Punkt in der Anstiegsspannung bestimmen, der das Flip-Flop aktiviert.

8. Modem nach einem der vorhergehenden Ansprüche, wobei die erste Schaltung einen Festleg- oder Klemmtransistor (140) aufweist, dessen Basis mit einem Q-Ausgang der Flip-Flop-Schaltung verbunden ist und der verbunden ist über ein Source-Gate des FET, um das Gate des FET dann zu erden, wenn die Flip-Flop-Schaltung getaktet ist.

9. Modem nach einem der vorhergehenden Ansprüche, wobei die zweite Schaltung ein Widerstands-Kondensator-Netzwerk (145, 147) aufweist, und zwar angeschaltet an einen Q-Ausgang der Flip-Flop-Schaltung, um den Q-Ausgang des Flip-Flop auf einem hohen Pegel zu halten, der das Gate des FET geerdet hält, bis die Anstiegsspannung verschwunden ist.

10. Verfahren zum Anstiegsschutz und zur Minimierung analoger Störungen in einem Modem, verbunden mit einem Telefonleitungs-system, wobei die folgenden Schritte vorgesehen sind:

Eliminieren des konventionellen Trenn-Transformators aus dem DAA-Abschnitt (9, 17); und:
Ändern der Signaltrennung oder Isolation von Analog-Signaltrennung zu Digitalsignal-Trennung;
Anordnen eines FET (107) in einer der ankommenden Telefonleitungen zum Öffnen und Schließen der Leitung;
Abfühlen einer Anstiegsspannung;
Hindern des FET am Stromleiten dann, wenn die Anstiegsspannung abgefühlt wird; und
Aufrechterhaltung der Verhinderung solange, bis der Anstieg vorübergegangen ist, wodurch sowohl übliche als auch unübliche Probleme eliminiert werden.

11. Verfahren nach Anspruch 10, wobei die Digital-Signaltrennung durch Verwendung einer magnetischen und optischen Isolation oder Trennung erreicht wird.

12. Verfahren nach Anspruch 10 oder 11, wobei ferner der folgende Schritt vorgesehen ist:
Erreichung der Trennung zwischen dem integrierten Analog-Abschnitt und dem digitalen Signalprozessor-Abschnitt.

13. Verfahen nach einem der vorhergehenden Ansprüche, wobei ferner der folgende Schritt vorgesehen ist:
Umwandlung des ankommenden Analogsignals auf der Telefonleitung in einen ersten Serienstrom oder eine Serienfolge von Digitaldaten vor der Digitalsignal-Trennung, und Umwandlung des abgegebenen Digitalsignals in einen zweiten Serienstrom von Digitaldaten vor der digitalen Signaltrennung.

14. Verfahren nach irgendeinem der vorhergehenden Ansprüche, wobei ferner der folgende Schritt vorgesehen ist:
Vorsehen der Digitalsignal-Trennung durch Verwendung von mindestens einem Impulstransformator für jeden Datenstrom.

Revendications

1. Modem démuni d'un transformateur classique d'isolement, comprenant en combinaison :

   un ensemble d'accès aux données sans transformateur (9, 17) en communication avec un système de lignes téléphoniques (19, 21 ; 109, 113),
   un dispositif analogique intégré (11'),
   un processeur de signaux numériques (13'),
   un microprocesseur,
   le dispositif analogique intégré étant connecté à l'ensemble d'accès aux données et le microprocesseur étant connecté au processeur de signaux numériques,
   un dispositif transformateur d'impulsions connecté entre le dispositif analogique intégré et le processeur de signaux numériques,
   des fils de ligne et de sonnerie destinés à assurer la communication entre les lignes téléphoniques et le modem,
   un transistor à effet de champ (107) connecté afin qu'il ouvre et ferme l'un des fils,
   un circuit de décrochage-raccrochage destiné à transmettre une tension de fonctionnement au transistor à effet de champ en mode de décrochage, et
   un premier circuit (140) et un second circuit (150),
   un circuit à bascule destiné à activer le premier circuit dans une première condition et le second circuit dans l'autre condition,
   un dispositif de détection (135, 161, 162) connecté entre les fils pour l'activation du circuit à bascule dans la première condition lors de la détection d'une surtension,
   le premier circuit (140) empêchant la conduction d'un courant par le transistor à effet de champ lorsque le premier circuit est activé, et le second circuit réarmant le circuit à bascule après un temps prédéterminé.

2. Modem selon la revendication 1, comprenant en outre :

   un dispositif multiplexeur (29) placé dans le dispositif analogique intégré et destiné à un signal reçu et un dispositif démultiplexeur (31) placé dans le processeur de signaux numériques et destiné à traiter le signal reçu,
   un dispositif multiplexeur supplémentaire placé dans le processeur de signaux numériques et destiné au signal transmis, et un dispositif démultiplexeur supplémentaire placé dans le dispositif analogique intégré et destiné au signal transmis, tous les signaux transmis et les signaux reçus passant dans le dispositif transformateur d'impulsions et étant numériques, si bien que la distorsion des signaux analogiques est évitée.

3. Modem selon l'une quelconque des revendications précédentes, comprenant en outre :

   un premier transistor (142) connecté au circuit à bascule pour qu'il se sature lorsque le circuit à bascule est commandé par un signal d'horloge,
   un second transistor (144) connecté au premier transistor et destiné à passer rapidement à l'état conducteur lorsque le second transistor conduit, et
   un trajet de court-circuit fermé par le premier et le second transistor et destiné au fil de sonnerie qui est mis à la masse pour la décharge de la capacité parasite comprenant la capacité éventuelle du transistor à effet de champ.

4. Modem selon l'une quelconque des revendications précédentes, comprenant en outre un circuit redresseur en pont (115, 117, 119, 121) connecté entre les fils de ligne et de sonnerie afin qu'il assure l'application d'une tension positive à un brin du transistor à effet de champ.

5. Modem selon l'une quelconque des revendications précédentes, comprenant en outre un circuit série (110, 112) à résistance-condensateur, connecté entre les fils de ligne et de sonnerie et destiné à être utilisé comme charge factice pour un signal de sonnerie.

6. Modem selon l'une quelconque des revendications précédentes, comprenant en outre une inductance électronique (150) destinée au modem et comprenant le premier et le second transistor et un circuit à résistance-condensateur en parallèle.

7. Modem selon l'une quelconque des revendications précédentes, dans lequel le dispositif de détection (135, 161, 162) comprend un circuit série qui comprend un condensateur et deux résistances et tel que le point commun des deux résistances est connecté à une entrée d'horloge du circuit à bascule, les valeurs relatives des résistances déterminant un point de la surtension qui active le circuit à bascule.

8. Modem selon l'une quelconque des revendications précédentes, dans lequel le premier circuit comprend un transistor écrêteur (140) dont la base est connectée à une sortie Q du circuit à bascule et qui est connecté entre le trajet source-grille du transistor à effet de champ de manière qu'une grille du transistor à effet de champ soit mise à la masse lors-

que le circuit à bascule est commandé par un signal d'horloge.

9. Modem selon l'une quelconque des revendications précédentes, dans lequel le second circuit comprend un réseau à résistance-condensateur (145, 147) connecté à une sortie $\bar{Q}$ du circuit à bascule de manière que la sortie Q de la bascule reste à un niveau élevé qui maintient la grille du transistor à effet de champ à la masse jusqu'à ce que la surtension ait disparu.

10. Procédé de protection contre les surtensions et de réduction au minimum de la distorsion analogique dans un modem connecté à un système de lignes téléphoniques, comprenant les étapes suivantes :

    l'élimination du transformateur classique d'isolement de la section DAA (9, 17), et
    le changement de l'isolement des signaux d'un isolement de signaux analogiques en un isolement de signaux numériques,
    la disposition d'un transistor à effet de champ (107) dans l'une des lignes téléphoniques entrantes de manière que la ligne soit ouverte et fermée,
    la détection d'une surtension,
    l'interdiction de la conduction d'un courant par le transistor à effet de champ lorsque la surtension est détectée, et
    le maintien de cette interdiction jusqu'à ce que la surtension ait disparu, si bien que les problèmes courants et non courants sont éliminés.

11. Procédé selon la revendication 10, dans lequel l'isolement des signaux numériques est réalisé à l'aide d'un isolement magnétique et optique.

12. Procédé selon la revendication 10 ou 11, comprenant en outre une étape d'accomplissement de l'isolement entre la section analogique intégrée et la section de processeur de signaux numériques.

13. Procédé selon l'une quelconque des revendications précédentes, comprenant en outre une étape de conversion du signal analogique entrant de la ligne téléphonique en un premier courant série de données numériques avant l'isolement du signal numérique, et la conversion du signal numérique sortant en un second courant en série de données numériques avant l'isolement du signal numérique.

14. Procédé selon l'une quelconque des revendications précédentes, comprenant en outre une étape de réalisation de l'isolement des signaux numériques par utilisation d'au moins un transformateur d'impulsions pour chaque courant de données.

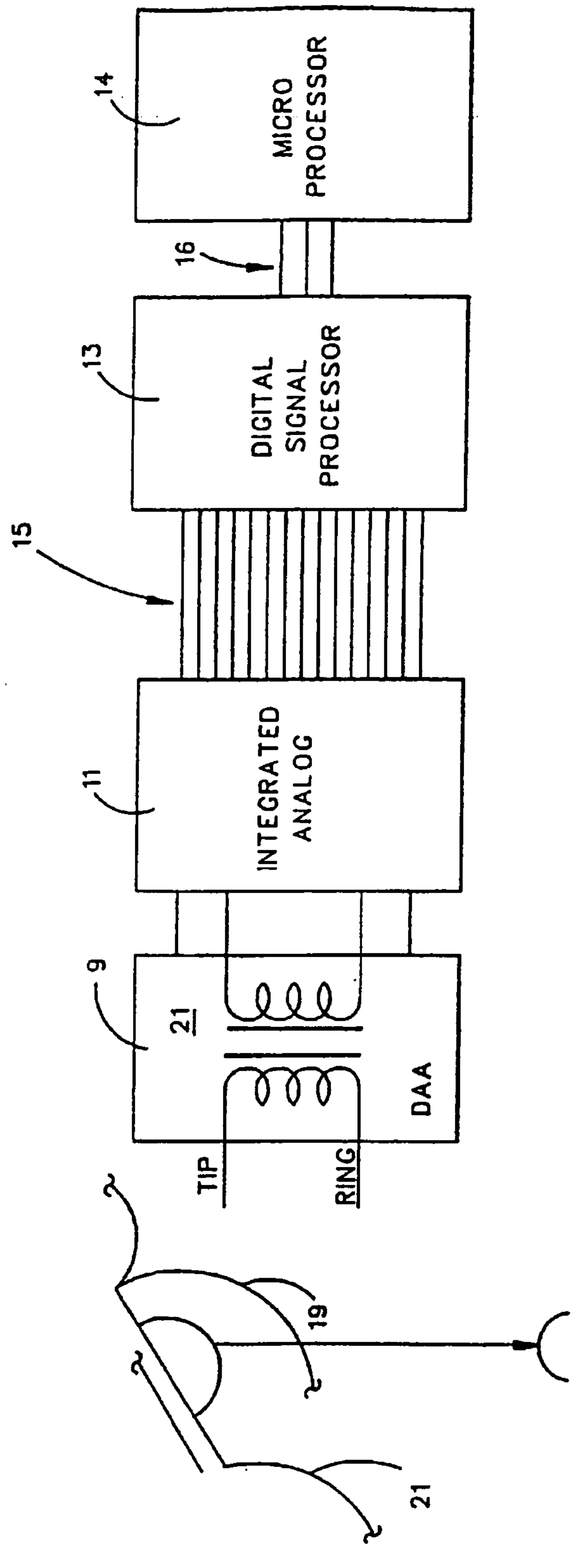


FIG. 1 PRIOR ART

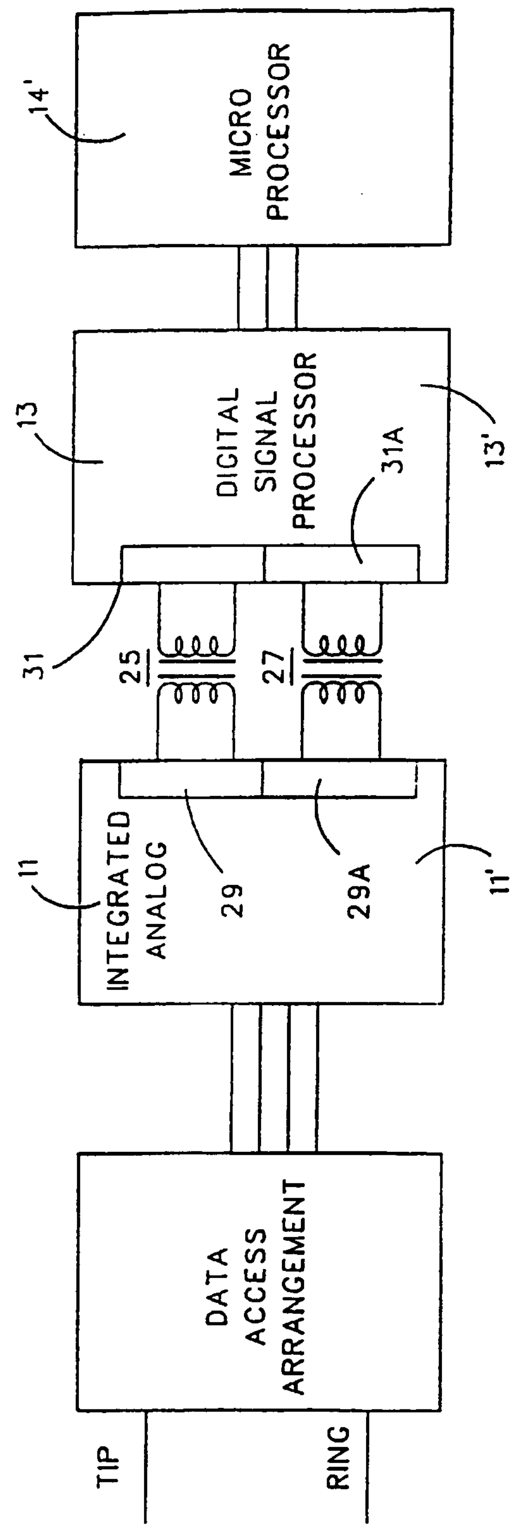

MICRO
PROCESSOR
14'
DIGITAL
SIGNAL
PROCESSOR
13
13'
31A
31
25
27
INTEGRATED
ANALOG
11
29
29A
11'
DATA
ACCESS
ARRANGEMENT
TIP
RING

FIG. 2

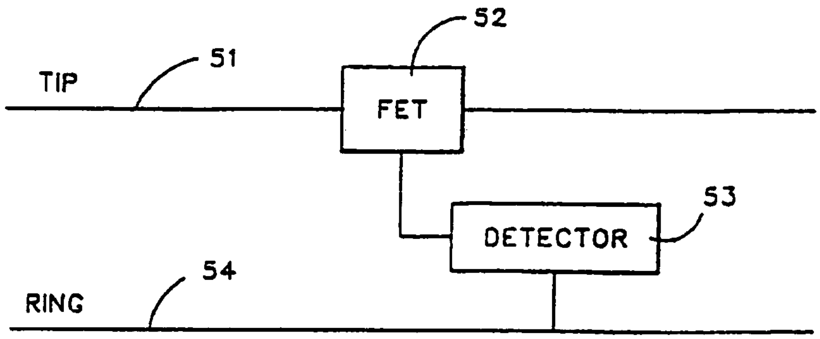


FIG. 3

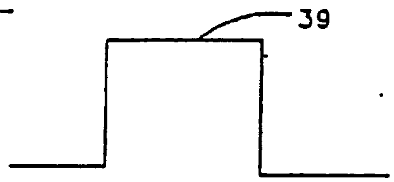


FIG. 4

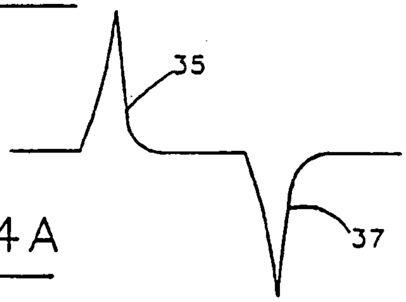


FIG. 4A

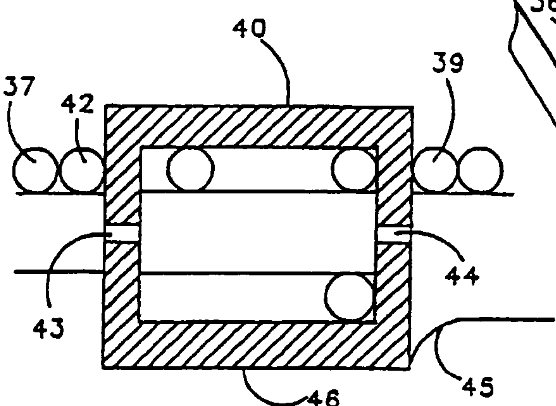


FIG. 5A

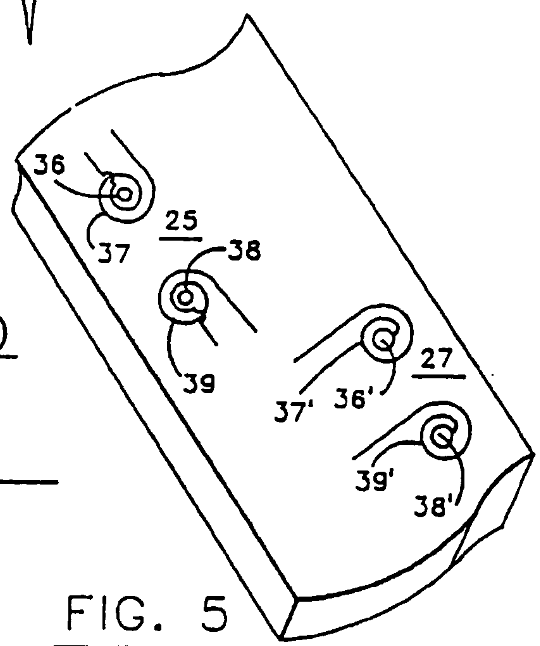


FIG. 5

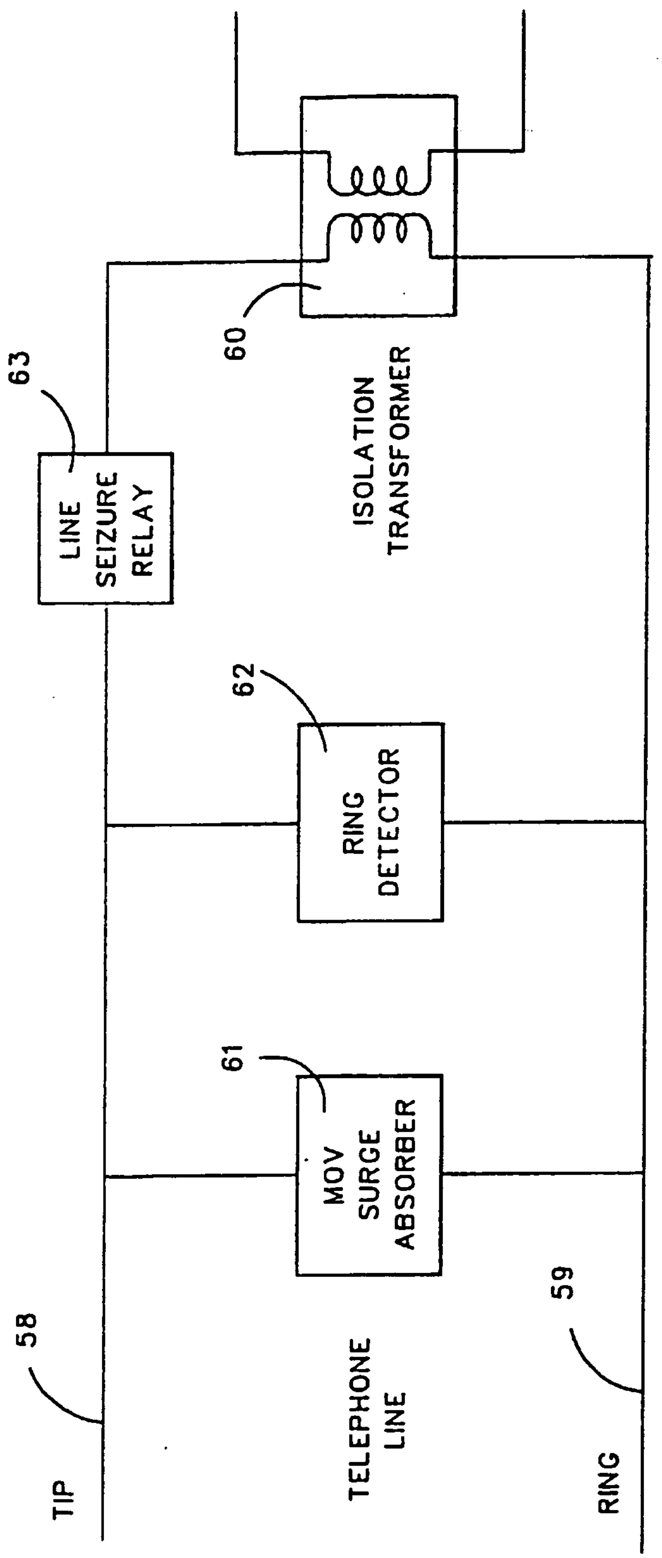


FIG. 6 PRIOR ART

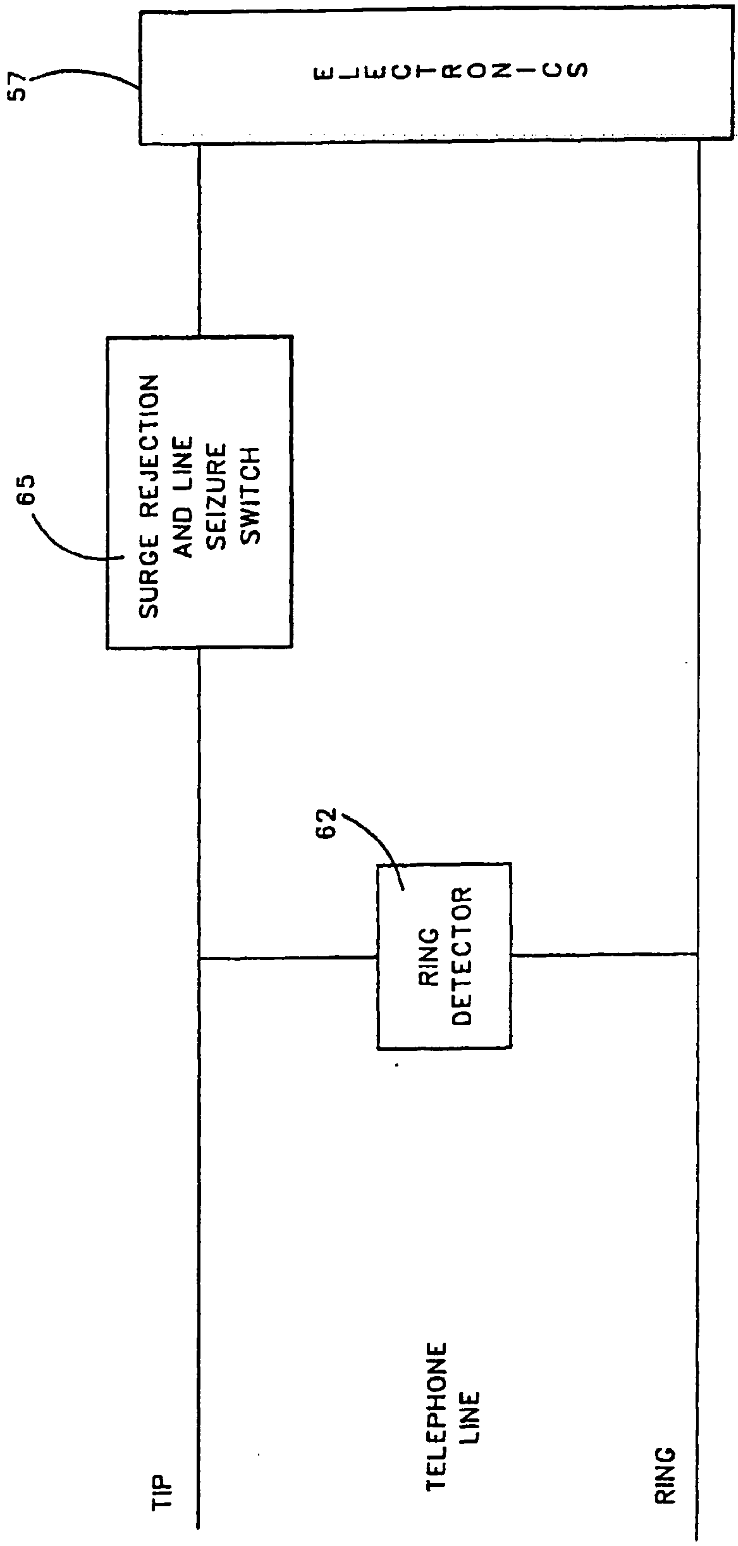
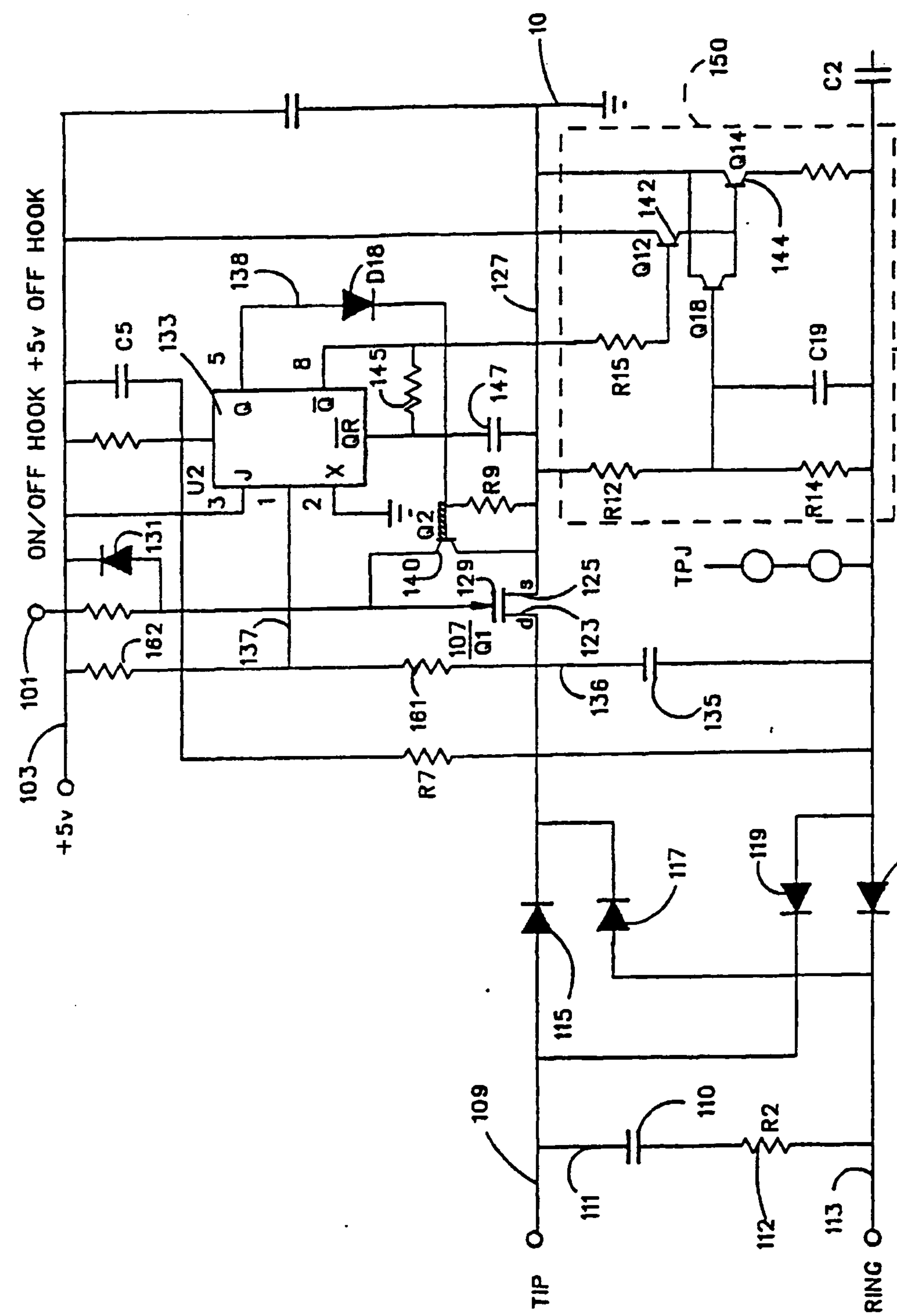

57
ELECTRONICS
65
SURGE REJECTION
AND LINE
SEIZURE
SWITCH
62
RING
DETECTOR
TIP
TELEPHONE
LINE
RING

FIG. 7



ON/OFF HOOK +5v OFF HOOK
+5v
103
101
162
131
C5
133
U2
J
Q
X
$\overline{Q}$
$\overline{QR}$
3
1
2
5
8
138
D18
145
147
R9
Q2
140
129
137
107
Q1
d
s
123
125
181
136
135
R7
10
127
150
C2
Q14
142
Q12
144
Q18
R15
C19
R12
R14
TPJ
115
117
119
121
109
110
111
R2
112
113
TIP
RING

FIG. 8